Report as of FY2009 for 2009PA98B: "Stream Storm Flow Dynamics Below Combined Sewer Systems: Human and Runoff Inputs"

Publications

Project 2009PA98B has resulted in no reported publications as of FY2009.

Report Follows

FY09 PROJECT REPORT (FINAL REPORT)
Pennsylvania Water Resources Research Center

Stream Storm Flow Dynamics Below Combined Sewer Systems: Human and Runoff Inputs

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PRINCIPAL FINDINGS AND SIGNIFICANCE

In the project proposal, we laid out three ambitious objectives. While these objectives were not met, clear progress was made on each. The objectives and summaries of progress for each below are included below:

1. Demonstrate fluoride (F) and temperature as tracers of domestic water inputs to urban fluvial systems. Demonstrating any hydrologic tracer is not a trivial task. However, our continued sampling and analysis continue to provide promising results. First, F concentrations remained between ~0.2 and 1.0 ppm (the level of F generally added to domestic water) throughout the project period, consistent with observations made prior to project funding. Unless, mechanisms dictating F concentrations in the water are coincidentally maintaining levels at ~1 ppm, this range of concentrations seems to indicate the presence of F derived from domestic water and waste water in NMR waters. Moreover, during periods characteristic of water line breaks (e.g., high suspended sediment and rapid discharge regression during dry weather) samples are positive outliers with F concentrations at or near the drinking water concentrations (Figure 1). This observation supports our contention that F can be utilized to identify domestic water contributions. However, some ambiguities remain, including the potential for F to precipitate with Ca or absorb to clay minerals. Therefore, we are currently seeking funding to analyze F concurrently with stable isotopes of water (δD and $\delta^{18}O$) and demonstrate the efficacy of the F tracer. With this additional demonstration, *F can be utilized* in any urban setting that fluorinates drinking water and does not have substantial mineral sources in local geology *to partition urban surface waters between domestic and meteoric sources.*

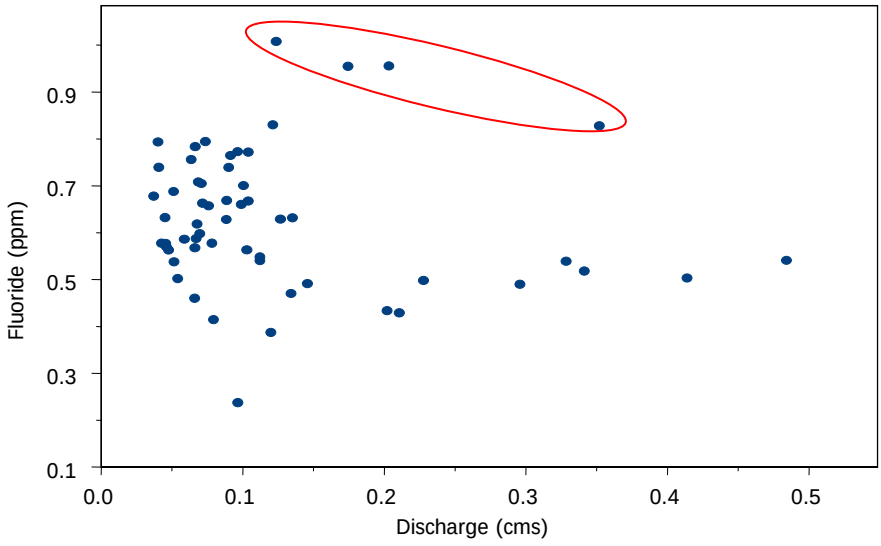

Figure 1 Fluoride Concentration vs. Discharge in Nine Mile Run just below its emergence from burial. Sample points circled in red all share a similar set of characteristics, including high suspended sediment load and rapid discharge regression during dry weather.

2. Collect high temporal density F concentration and temperature data in stream and sewer portions of Nine Mile Run, with particular attention to wet weather periods. A continuous, five minute interval record of temperature has been collected via instruments installed at several locations in Nine Mile Run. In particular, we have established coupled stations at the combined sewer outfall and immediately upstream of this outfall (Figure 2). This record indicates sufficient contrast to allow for mixing models based on temperature and therefore quantification of discharge contributed by the outflow during storm flow. A third temperature sensor downstream of the outfall was recently installed and should provide such a record in the near future. *Development of this method provides a cheap, reliable means to characterize and monitor combined sewer inputs to urban streams.* Temporally dense fluoride concentration measurements have proven to be less simple. Utilization of fluoride ion selective electrodes (F-ISE) in natural waters requires buffering and use of chelating ligands to reduce interferences. Much of our time has been spent in the lab evaluating available commercial mixtures with minimal success. We are currently seeking funding to allow the sustained effort of a graduate student and the acquisition of commercial, automated F-ISE packages to minimize engineering necessary on our end. In addition, this week we have collected samples through our first storm hydrograph using the automated water sampler installed with project funds. Analysis of these samples should provide data regarding F concentration dynamics during storm flow. *Ultimately, the combination of high temporal resolution CSO temperature monitoring and fluoride concentration should provide strong insight into urban hydrologic systems advancing both applied and mechanistic understanding.*

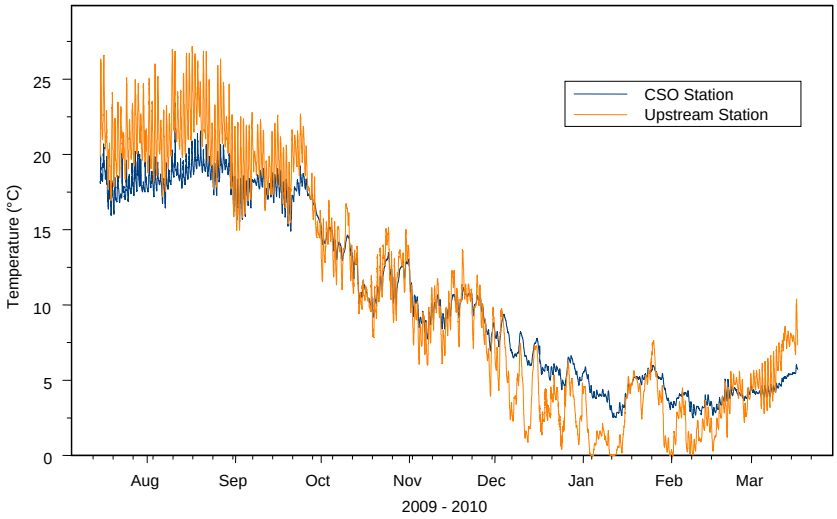

Figure 2 Five minute interval temperature record from coupled stations in Nine Mile Run. The blue line indicates temperature measured at a combined sewer outfall and the orange line in stream temperatures directly upstream of the outfall.

3. Use this data to determine the role of sewer inputs in Nine Mile Run's discharge and particularly to evaluate the impact of human water consumption on storm flow patterns. As noted above, these high temporal density records remain in progress. However, once collected, these data should provide a strong dataset for understanding urban hydrology and methodology that can be broadly applied.

Other findings:
Project funding allowed additional examination of metal concentrations in these samples. In particular, waters downstream of the slag in Nine Mile Run are enriched in aluminum and

potassium, potentially providing a means to evaluate the prevalence of slag throughout the region (a challenging task due to poor record keeping) and/or predict the ecosystem impacts of slag on local waters (e.g., how does this excess potassium impact instream biotic communities?) *These tracers of slag provide a tool for evaluating water-steel waste interactions in steel production regions around the world.*

STUDENTS & POSTDOCS SUPPORTED

Katelin Fisher, Department of Geology and Planetary Science, 2009 BS Geology (Currently a Masters Student, Department of Earth Sciences, Indiana University Purdue University at Indianapolis)
Erin Wozniak, Department of Geology and Planetary Science, 2010 BA Environmental Studies (Currently employed by the Friends of the Pittsburgh Urban Forest)

PUBLICATIONS

None yet.

PRESENTATIONS AND OTHER INFORMATION TRANSFER ACTIVITIES

E. P. Wozniak, K.R. Fisher, D. J. Bain "Tracing Domestic Water Inputs to Pittsburgh Streams", Poster presented at *Science Unplugged*, University of Pittsburgh, October 15, 2009

E. P. Wozniak, K. R. Fisher, M. T. Sikora, E. M. Elliott, D.J. Bain "Tracing Domestic Water Inputs to Pittsburgh Streams" Poster presented at *Pennsylvania Water Symposium*, Pennsylvania State University, May 6, 2010

D. J. Bain, M. T. Sikora, E. P. Wozniak, K. R. Fisher, E. M. Elliott "Adaptive Management in Urban Stream Restoration: Balancing Water Quality and Channel Structure" Invited Talk to be presented at *2010 Ecological Society of America Annual Meeting*, Pittsburgh, PA

AWARDS

None.

ADDITIONAL FUNDING ACQUIRED USING USGS GRANT AS SEED MONEY

University of Pittsburgh Office of Experiential Learning Small Grant for Undergraduate Research, $500, 9/1/2009-12/31/2009,"Tracing Domestic Water Inputs to Pittsburgh Streams"

NSF-Hydrological Sciences, $300,000, 5/1/2011-4/30/2014, "Development of Hydrologic Tracers For Characterizing Urban Catchment Hydrology" (submission planned 6/1/2010)